HPP TO IMPROVE WATER RETENTION OF SODIUM-REDUCED FROZEN CHICKEN BREAST GELS WITH TWO ORGANIC ANION-TYPES OF POTASSIUM SALTS

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Abstract – The effect of high-pressure pretreatment (HPP, 100-300 MPa) on cooking-loss (CL) and water-holding capacity (WHC) of sodium-reduced (1.35% NaCl), frozen chicken muscle gels with potassium lactate (KL-gel) and potassium citrate (KC-gel) of organic anion-types was investigated. Results showed that 100-200 MPa could significantly decrease CL of both gels, and 200 MPa increase WHC of KC-gel (P<0.05). HPP could facilitate gelation with a dense and uniform microstructure, immobilize free water and thus induce an enhanced water retention. The pressurized KC-gel had a better water retention compared with KL-gel, while the WHC and CL difference between the gels was reduced at 300 MPa. These indicated that proper HPP could be an available choice for developing sodium-reduced meat products with organic anion.

Key Words – Cooking Loss, Water holding capacity

I. INTRODUCTION

As is well-known, high-sodium intake can induce cardiovascular diseases. NaCl plays a key role in meat processing and qualities, and potassium lactate (KL) was applied to intensify NaCl action [1]. Alkaline potassium citrate (KC) could maintain overall acceptance of reduced salt [2]. High pressure pretreatment (HPP) could improve the gel properties of low-salt meat products, and freezing and thawing of meat had been found to reduce its quality. However, there is no literature about the effects of HPP on water retention in sodium-reduced and frozen meat gels with organic potassium salts.

The main objective of this work was to investigate the improvements of HPP (100-300 MPa) on the water retention in sodium-reduced (1.35% NaCl) frozen chicken breast gels with two organic anion-types of potassium salt (KL and KC), in order to stimulate the development of low-salt meat products.

II. MATERIALS AND METHODS

All of the meat batters were prepared with addition of 1.35% NaCl and potassium salts to get KL-batter (1.6% KL) and KC-batter (0.8% KC). 100, 200 or 300 MPa for 10 min was applied to the batters of HPP-group, and then all of the batters were heated in a water bath set to 80 °C for 20 min to form a gel.

Cooking loss (*CL*) was determined by calculating the weight difference before and after cooking. Water holding capacity (*WHC*) was expressed as the percentage of the gel's weight retained after centrifugation (3000 g for 15 min at 4 °C). Low-field nuclear magnetic resonance (LF-NMR) and scanning electron microscopy (SEM) determination were performed, respectively.

ANOVA was completed with Microsoft Office Excel 2007. A significant level of $P<0.05$ was used.

III. RESULTS AND DISCUSSION

A. CL and WHC

The CL of both KL- and KC-gel decreased clearly (P<0.05) with the elevated pressure from 0.1 to 200 MPa, whereas the change of CL was insignificant (P>0.05) between 200 and 300 MPa (Fig. 1A). This decrease could be attributed to the HPP-induced changes of meat proteins, such as the improvement of myofibrillar proteins solubility, decrease of particle size, enhancement of hydrophobic interaction [3].

As shown in Fig. 1 B, the WHC of both pressurized KL-gel and KC-gel are unchanged (P>0.05) with the elevated pressure level, except for a significant improvement in WHC of KC-gel under 200 MPa (P<0.05). It suggested that the HPP-induced variations could be attributed to the organic anion-types, because the meat proteins with different salt conditions exhibited different sensibilities to HPP.

In addition, the KC-gel showed much stronger water retention ability than that of KL-gel both CL and WHC, and the ability was enhanced with HPP (Fig. 1).

B. LF-NMR

As showed in Table 1, the KC-gel showed a higher P_{21} and a lower T_{22} than KL-gel, and 200 MPa induced a significant increase of T_{21} and P_{21} in KC-gel ($P<0.05$), indicating that free water partially transformed to immobilized water. HPP could induce unfolding of meat proteins, leading an increase of free side chains (more charged groups) and intermolecular space, enhancing water-protein interactions[4], which resulted in a higher WHC of KC-gel under 200 MPa (Fig. 1B).

Table 1 T_2 relaxation time and proportion of its peak area of KL- and KC-gel

[a-c] Means with different letters in the same line are significantly different ($P<0.05$). P_{21}, P_{22} are proportion for T_{21}, T_{22}

Sample	KL-0.1 MPa	KL-200 MPa	KC-0.1 MPa	KC -200 MPa
T_{21}	37.65±0 [a]	37.65±0.18 [a]	37.65±0 [a]	43.29±0 [b]
P_{21}	96.15±0.12 [a]	96.50±0.60 [ab]	96.41±0.18 [a]	96.79±0.17 [b]
T_{22}	386.17±30.36 [b]	320.63±26.40 [a]	498.91±40.13 [c]	335.87±26.40 [ab]
P_{21}	1.65±0.30 [b]	1.00±0.38 [ab]	1.22±0.17 [b]	0.71±0.14 [a]

C. SEM

The added KC and HPP of 200 MPa could induce a more continuous and uniform gel matrix (Fig. 2), thus enhancing the water retention of the sodium-reduced and frozen chicken breast gels.

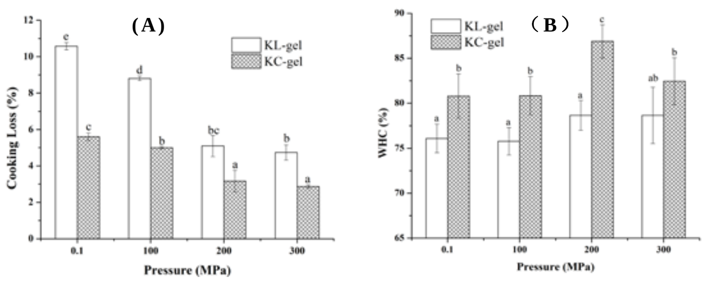

Figure 1. Effects of the pressure levels for 10 min on the CL (A) and WHC (B) of KL- and KC-gels
a-e on the histograms indicates that the different letters are significantly different ($P<0.05$).

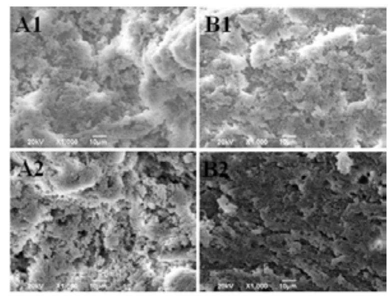

Figure 2. SEM images with 1000× magnifications of KL-gels non-pressurized (A1) and 200 MPa for 10 min (A2), KC-gels non-pressurized (B1) and 200 MPa for 10 min (B2)

IV. CONCLUSION

KC induced much stronger water retention ability than KL in sodium-reduced chicken breast gels. And the decreased extent in CL was enhanced under 100-300 MPa, while the increased degree in WHC was did under 200 MPa. These could be attributed to the decreased mobility of water in KC-gel pressurized, and the formation of continuous and uniform gel matrix.

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